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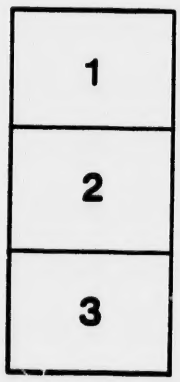

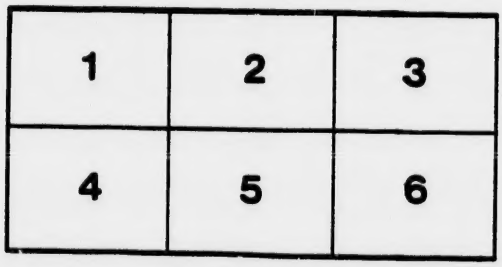

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REPORT

ON THE

LAKES AND RIVERS

WATER AND WATER-POWERS

OF THE

PROVINCE OF ONTARIO

By E. B. BORRON, Esq.
Stipendiary Magistrate.

PRINTED BY ORDER OF THE LEGISLATIVE ASSEMBLY.

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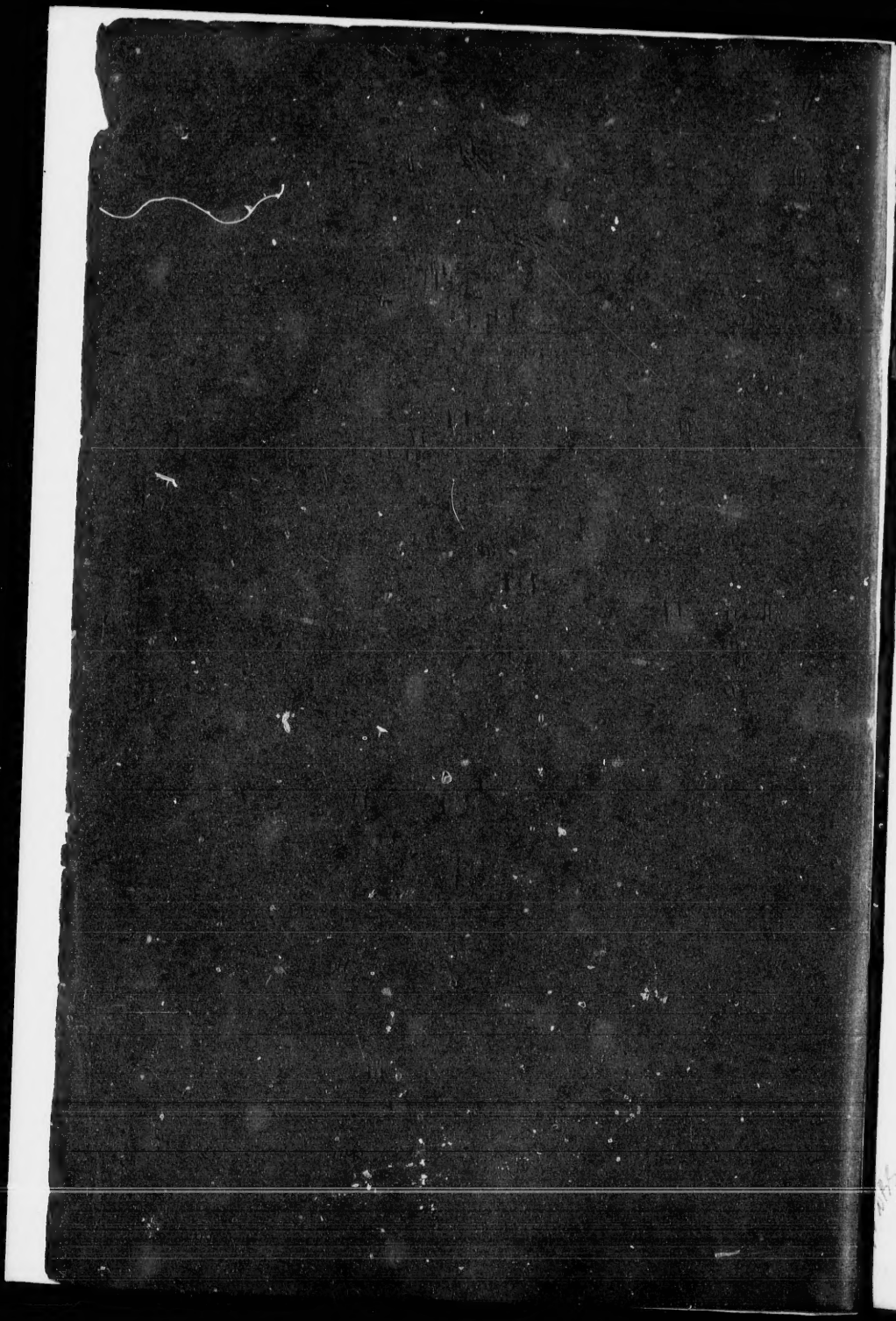

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TORONTO, 30th April, 1891.

Hon. O. MOWAT,
Attorney-General, etc., etc.,
Toronto.

SIR,—I have the honour to submit herewith a report on the water and water-powers of the Province of Ontario.

The object of this report is, to show the great importance and value of the lakes, rivers and streams with which Ontario (more especially the northerly and westerly parts thereof) abounds.

It is also designed to impress on the Government the necessity which exists for the largest possible provincial control if the people of the province are to derive the largest possible benefit from the natural advantages which affords these lakes, streams and rivers, due regard being had to the reasonable claims of our sister provinces.

In order to this and to the conservation of the public rights or interests therein, various suggestions are respectfully offered for your consideration.

I have the honour to be,
Sir,
Your most obedient servant,

E. B. BORRON,
Stipendiary Magistrate.

REPORT OF

E. B. BORRON,

STIPENDIARY MAGISTRATE,

WITH RESPECT TO THE

LAKES AND RIVERS, WATER AND WATER-POWERS OF THE PROVINCE OF ONTARIO,

MORE PARTICULARLY THOSE IN THE NORTHERLY AND WESTERLY PARTS, WITH SUGGESTION IN REGARD TO THE CONSERVATION OF PROVINCIAL AND PUBLIC RIGHTS THEREIN.

In the reports which the writer has had the honour to submit, from time to time, to the Honourable the Attorney-General, for the information of the Government, the leading topographical features of the Provincial Territory on and beyond the height of land, and its agricultural, mineral, timber, and other resources have all been, more or less, particularly described.

In compliance with the instructions received at the time of his appointment, "that he would be expected to procure and forward information, and to advise and assist in settling all matters relating to our new territory:" he has procured and submitted all the information he could obtain in reference to the social condition of the native and other inhabitants of this vast territory. And as they are not represented in either the House of Commons or the Legislative Assembly and had no other means of doing so, he has not failed to lay before the Government and Legislature what have appeared to him their most imperative wants and serious grievances, with such suggestions and advice as to the proper mode of dealing with, or settling the same, as seemed to him best. But the economic value of the numerous lakes, and of the rivers and streams to which they give birth, has not been as fully and exhaustively dealt with as the great importance of that subject unquestionably demands.

The object of the present report, therefore, is to supply further information with respect to the lakes and rivers in order that that their true value may be appreciated and understood, and steps taken to protect or guard the interests of the Province and of the people at large, in connection therewith.

The enormous extent of the inland waters of the Province of Ontario is well known. Even if the meaning of the term "inland waters" be confined to those lakes and rivers only which lie entirely within her own territory, the area of this "submerged land" is equal to that of the whole of Nova Scotia.

The importance and value of these inland waters to the Province consist chiefly:—

1st. In the fish which they contain.

2nd. In the navigable water-stretches they afford.

3rd. In the land which may be reclaimed.

4th. In the unfailing water-power they supply.

Fish.

It is hardly necessary to say that fish of some kind are found in every lake and river in the Province; but with the exception of Lakes Superior, Huron, Erie and Ontario (usually called the great lakes), and of Lake Nipigon, Lake of the Woods, Lac Seul, and a few others, by far the greater number of the lakes do not, in their natural condition, contain fish in such quantity or of such kind as to support what are commonly understood as being meant by the term "Fisheries."

Under a judicious system of "pisciculture" however, many of them might, it is believed, be rendered very productive.

In his report for the year 1883, pp. 64, 65 and 66, the writer, when then dealing with this subject, says, "The plateau which forms the height of land and extends many miles both north and south of the actual watershed, is a perfect network of lakes. The most considerable of these are Lake Nipigon, lying a short distance south, and Long Lake immediately north of the watershed. There are however, hundreds of other lakes varying in size from fifty acres to fifty square miles. Nor are they confined to the height of land plateau between Lakes Huron and Superior and James' Bay, for they are nearly, if not quite, as numerous west of Lake Superior, and in some parts of the country lying between the Georgian Bay and Ottawa Valley. In addition to those lakes which lie entirely within our Province, there are other lakes situated on the boundaries, and which are partly so. Such lakes for instance as Abittibi on our eastern boundary, and Rainy Lake, Lake of the Woods, Lac Seul or Lonely Lake, and Lake St. Joseph, on our southern and western boundaries. These again are exclusive, entirely, of what we call our "great lakes," Superior, Huron, Erie and Ontario, one half of which, or more, properly belongs to the Province of Ontario. What may be the total area of the submerged land, or in other words, lakes included within the boundaries of the Province of Ontario, no one in the present state of our knowledge of the country can truly estimate. Of the great lakes alone, probably not less than 30,000 square miles are in Ontario. Assuming the area of all the other lakes in the Province (inclusive of the disputed territory), to be 20,000 square miles, and I am persuaded it is not less, we have 50,000 square miles of submerged land. Much of this will in the future be drained, and millions of acres of land reclaimed. More of this must remain forever covered with water, and may be utilized partly for the purposes of navigation, and partly as affording wholesome food in the form of fish.

The great number of lakes, and the vast area, embraced within the limits of this Province, has been already adverted to. The people who assume these lakes to be valueless from a provincial point of view, fall into the same error as those who contend that the land, minerals, timber and other resources of this territory

are worthless; they take it for granted that the world is going to stand still. Mine is a different faith. I believe that this territory, hitherto so inaccessible, is on the eve of being opened up, and all its various resources developed. Now, as regards fish, the larger lakes, more particularly Lake Nipigon, are capable of affording employment to many fishermen, and of yielding, at least for a time, considerable quantities of excellent fish without any particular care or attention. But in the future, when the art of fish-breeding and raising shall be as well understood and as systematically practised as cattle-breeding or the raising of poultry, I think the smaller lakes will be more valuable, and produce more fish in proportion to their area than the larger ones. They will be much more manageable, so to speak, and thus afford a better opportunity for the exercise of the knowledge and skill which mankind have acquired, or may hereafter acquire, bearing on the successful practice of what is called "pisciculture" or fish culture. Left simply to the operation of natural laws, our lakes and rivers contain fish and "fishes," if I may be pardoned for using such an expression. By fish, I mean those kinds which obtain their nourishment from sources which directly contribute little or nothing toward the sustenance of man. For example, all those varieties of fish which feed upon insects, or the larvæ of insects, worms, snails, grubs, caterpillars, grasshoppers, upon mollusca or shellfish, or crawfish, and even on minnows, or other small fish, which however numerous, would be of little or no importance as food for man. I include under this head also all those kinds of fish, if there be such, as are vegetarians or herbivorous, drawing their subsistence, in whole or in part, from the grasses and plants growing on the submerged land or in the water itself.

By "fishes" I would be understood to mean predatory or carnivorous fishes, which live by devouring, for the most part, the other kinds of fish referred to above, namely, those which, while themselves good for food, consume nothing which man himself could or would eat.

Now, without having made a study of the subject, it appears to me that the aim of the fish culturist should be to keep such kinds and such numbers of fish as will utilize all the fish food afforded by his pond or lake; preferring of course those kinds which will yield the largest return, in respect of quantity and quality of human food. On the other hand the predatory fishes, such as the pike, should, it seems to me, be entirely banished or excluded from the ponds or lakes, if possible. The result of allowing such fishes to remain being, that although they may in due time themselves become the food of man, they will probably have consumed more than twenty times their weight of better fish, which, but for them, might also have become human food. This would be anything but true economy. We know pretty well how many pounds of corn it takes to make a pound of pork, or a pound of beef; but we are entirely in the dark (at least I am) as to how many pounds of herring or white-fish are required to make a pound of pike, of dore or pickerel, or even of lake trout. It is difficult to form even a conjecture on the subject, but I am inclined to think that in putting it at twenty times their own weight, I am very much below the truth. If this is so, those smaller lakes, in respect of which an intelligent system of pisciculture can be adopted, will, as I have said, be more valuable and productive in proportion to their area, than the larger lakes. Fish-breeding can be carried on in the smaller lakes by private individuals. If favourably situated as regards drainage, inferior kinds of fish, such as the sucker, and the predatory fishes, such as the pike, can be weeded out, and only those which are in every respect desirable retained; or foreign stock might be imported and introduced, in some cases, with decided advantage. In the large lakes, where it is practically impossible to do this, there can be no scientific pisciculture in the proper sense of

the term. Still, much can be done to increase the produce even of the largest, by wise fishery laws or regulations, the object of which should be to aid and encourage the multiplication and increase of such fish as the white-fish, and to reduce, as much as possible, the numbers of the predatory fishes, of which the pike may be taken as the type.

The inadequacy (as it humbly appears to me) of our fishery laws may be inferred from the simple fact that not only the pike, but every other kind of predatory fish is actually protected, while the sturgeon, one of the most valuable of fresh-water fishes, is, I believe, altogether unprotected.

The following extracts are taken from an interesting article on "Pisciculture," in Chambers' Encyclopædia:

"The Chinese have long bestowed more attention on pisciculture than any other nation, and with them it is truly a branch of economy, tending to the increase of the supply of food, and of the national wealth. In some countries of modern Europe this branch of pisciculture is also prosecuted to a very considerable extent, particularly in Germany and Sweden, and of late years in France, in order to the supply of fish for the market. In Britain it has never been systematically prosecuted. In Germany, ponds carefully attended to, are found very productive and remunerative. There can be no doubt that in Britain, also, many a piece of land, at present very worthless, might easily be converted into a pond and be made to yield large quantities of excellent fish; but such a thing seems almost never to be thought of. Modern pisciculture is the revival of an old art, well-known to the ancient Italians, but which has fallen into abeyance for a number of centuries. The art of breeding and fattening fish was well-known to the luxurious Romans. The art had doubtless been borrowed from the ingenious Chinese, who are understood to have practised the art of collecting fish-eggs and nursing young fish, from a very early period. Fish forms to the Chinese a most important article of diet, and from the extent of the water territory of China, and the quantities that can be cultivated, it is very cheap." After an interesting account of fish hatching as pursued at Hunungue, in France, the writer goes on to say: "The art of pisciculture has also been introduced into Ireland, at the fisheries of Loughs Mask and Carra by the Messrs. Ashworth, who have obtained excellent practical results form their enterprise. The loughs contain an area of of water equal to thirty-five acres,* and a communication with the sea having been opened they now teem with salmon; and the proprietors are confident that it is as easy and as profitable to cultivate salmon as sheep." This article concluded as follows: "There is no practical difficulty, it is said, in rendering an acre of water as productive as an acre of land."

If this be so now, or if as our knowledge of the art of fish culture increases, there be the remotest probability of "An acre of water being rendered anything like as productive as an acre of land," how important and valuable must be the 20,000 square miles or 12,800,000 acres of water (exclusive of the great lakes) included in the Province of Ontario be! How proper that every precaution should be taken to maintain the right of the people of the Province thereto as against all claimants.

Since the report, just quoted, was submitted the writer has had further opportunity of making enquiries and observations on this subject, which have modified to some extent the views and opinions therein expressed. He is now convinced that the lakes and rivers situated on and to the north of the height of land plateau are not capable of nourishing or sustaining nearly as many fish as

*This should, I think, be square miles. Thirty-five acres is a very small sheet of water.—E.B.B.

those of the same size in Europe—or even the lower lying and deeper lakes south of the watershed. This is owing most likely to a deficiency of food or organic matter, animal or vegetable. It may well be that this should be the case during the long and severe winters; but on the other hand many kinds of fish require little food at that season. Two important articles, however, of fish-food are either entirely wanting or very scarce—there are no earth-worms—and as compared with Southern Canada and the Northern States there are very few frogs; and probably other kinds of food may be more or less deficient. Again, lakes in lower lying districts receive the waters of numerous streams and brooks which supply the fish therein with a great deal of food. But those on the height of land plateau have comparatively few and unimportant tributary streams. Hence another cause of the scarcity of food. The presence of leeches, too, in considerable numbers in many of these lakes is no doubt more or less prejudicial. That leeches do kill even large fish is certain—the writer in one instance found a dore or pickerel about two pounds in weight dying and with the leech still attached to it, and has repeatedly caught or seen large pike thin and emaciated and showing wounds inflicted on them as it is believed by leeches. It is probable therefore, to say the least, that the leech may destroy large numbers of small fish, if not also a great deal of the ova or spawn.

As many of these lakes can be drained at a moderate expense, sluices by which the water might be drawn off at pleasure—as is usually the case in fish ponds—would enable the owner or lessee to rid himself of such noxious creatures —and of all such fishes as the pike, whose presence in the lake is either positively injurious or otherwise undesirable. And at the same time would admit of its being restocked with other more valuable kinds of fish. Another advantage afforded by such an arrangement would be that the fish could be taken with little or no trouble or labor for sale or consumption whenever required. It is possible that the "Carp" so valuable in this connection—in Europe might prove a profitable kind of fish in this country. The writer has caught a variety of trout in Ballygrant (an almost land-locked lake in the Island of Islay, Scotland,) and in other completely land-locked "Lochs" or lakes high up in the hills of Argyleshire —which he believes if introduced into the lakes on the height of land plateau would as certainly succeed as the Highlandman himself does when planted on the soil of Canada. This loch-trout, while differing from the brook-trout, is not the large lake trout or "salmo-ferox" of that country, nor is it the salmon-trout of our great lakes. While the trout caught in other lochs weighed generally from a quarter of a pound to a pound weight—those taken in Ballygrant Loch averaged nearly two pounds in weight. The flesh of this variety of the lake trout is of a yellowish or pinkish tint and of fine flavor. It rises freely to the fly and affords the true angler the sport which he most eagerly desires and heartily enjoys.

If the rights of the Province in respect of these inland lakes were fully established it would be very desirable and greatly in the interest, not of anglers only, but of the public generally that suitable lakes should be selected in which to carry out experiments of the character indicated in the preceding paragraph, We have, and that very properly, experimental farms, the object of which is to find out what plants and what breeds of domestic animals are best adapted to the conditions of soil and climate in various parts of the country, and which can at the same time be cultivated or raised with the greatest advantage. Valuable experience and results have thus doubtless been obtained. In like manner—may we expect—that carefully conducted experiments, with the view to ascertaining what kinds of fish can be raised with the greatest success in our inland waters, will also be attended with valuable results.

The expense could not be very great, and if the results be such as may be reasonably expected they cannot fail to give an importance and value to these lakes, which unimproved and uncultivated they will never possess. Not only may they be made to yield a very large amount of food but of revenue; and at the same time afford to those who desire or stand in need of recreation one of the most healthful, harmless and innocent of all "sports."

Navigation.

In regard to the value of the inland lakes and rivers of Ontario for the purpose of navigation it is not necessary to say very much. They have in times past been not only useful but indispensable alike to the hunter, the trapper and the fur-trader; to red men and to white. They have been almost equally valuable in this respect to the first pioneers and settlers—whether farmers, lumbermen or miners. Such navigation as they are capable of affording is still valuable in all those parts of the Province unprovided with other means of transport or of travel. The circumstance however that these lakes and rivers can be traversed by birch-bark canoes and flat-bottomed boats for long distances—what are called "portages," being made from lake to lake or around obstacles such as water-falls in the rivers—and that loads of two or three tons may be thus laboriously transported from one point to another, even if in different provinces, does not constitute either the lakes or rivers "navigable" in the generally accepted sense and meaning of that term.

Exclusive of what are called the great lakes and those other lakes through which the international and provincial boundary lines pass—possibly about ten per cent. of the "inland lakes" (or those lying entirely in the Province) afford what may be reasonably called "Navigable stretches" varying in length from five to fifty or sixty miles.

Of those probably not more than a score afford navigable stretches over twenty or twenty-five miles in length.

These navigable water-stretches almost invariably on other than boundary lakes, begin and end in the Province. And as they can be of no conceivable use or advantage to the people of the other provinces should, it seems to the writer, be under the exclusive control of the Government of Ontario.

3rd. Submerged Land.

It may be truly said of some lakes that the water is worth more to the Province than the land which it covers. And of other lakes it may be said with equal truth that the submerged land or "bed" is more valuable than the water.

Where the latter occurs it is in respect of those lakes, such as Abittibi, Bank Lake, Nighthawk Lake and others which are not only very shallow but so situated as to admit of easy drainage.

This was shown by the writer in his report for 1888-89 on that part of the Provincial territory in which these lakes are situated. And it may not be out of place to repeat here what was there said. On page 22 *et seq.* will be found the following remarks:—

"There is one feature common to almost all the lakes in this territory which I regard as of the greatest importance in estimating its capabilities and value in an agricultural point of view. And that is the remarkable shallowness of the water and the apparent ease with which many of these lakes can be drained and vast areas of fertile land reclaimed.

"For instance, in this south-eastern portion of the territory we have Lake Abittibi with an area of not less than four hundred square miles—and incredible as it may appear—a mean depth of water in the summer not exceeding, in my opinion, ten feet. The soundings taken by us on the south side of of the lake never exceeded nine feet, even in the widest stretches and when furthest from the shore. I have been told, however, that it is somewhat deeper on the north side of the lake, though shallow even there. Then we have Bank Lake, the area of which is seemingly thirty or forty square miles, and the average depth of which, judging from what I saw of it, does not exceed six feet. And, thirdly, there is Nighthawk Lake with its marshes covering an area of at least one hundred square miles, and yet nowhere that we sounded is it more than ten feet in depth. Thus without taking into account the smaller lakes, such as Round Lake and numerous marshes, I find in the comparatively limited section explored this season not less than five hundred square miles or three hundred and twenty thousand acres, the far greater part if not all of which can, in my opinion, be drained at a very trifling cost as compared with the value of the land reclaimed.

"Lake Abittibi is very advantageously situated in this respect, there being at its outlet a fall "called Couchiching," which is estimated to be about fifty feet. If the apparently narrow reef of rock over which the water descends were only partially removed it would, so far as I am able to see and judge, in all probability completely drain the greater portion of the lake above.

"In Europe very costly operations of this description have been undertaken with the view of reclaiming areas of land, a tithe only of what might be expected in the case of Lake Abittibi. One notable instance is that of Haarlem Lake in Holland, where forty thousand acres of fine land were thus reclaimed. In that case, however, the water had actually to be pumped out. This, difficult as it may appear, was successfully accomplished by an English company who employed several large and powerful steam-engines made, if I am not mistaken, in Cornwall, famous in those days if not still for the excellence of its pumping engines and machinery. It took a number of years, however, to drain the lake, and even when completed some of the engines had to be retained in order to keep it drained, for the bed of the lake being below the level of the sea the water could not otherwise be got rid of.

"Lake Abittibi on the other hand is at least seven hundred feet above the level of the sea, and at its outlet there is a sudden drop or fall of fifty feet or to a level forty feet below the bottom of the lake. The reef of rock which occurs at this place has at one time been much wider if not higher than it is at present. But the action of the water and ice, operating slowly but surely during unnumbered ages, has broken down and removed the greater part of this barrier; and now, so far as I am able to see, there remains comparatively little to be done in order to complete the drainage of this immense lake.

"If a passage were cut through the remaining portion of this reef of rock sufficiently wide and deep to discharge or let off the water at this point, very little further expense would I think be necessary. The main river and tributary streams would soon excavate channels for themselves in the clay of which, in my opinion, the bed or bottom of the lake is chiefly if not entirely composed. The uniformity of the depth, the color of the water and the character of the soil in the marshes and swamps as well as on the islands all tend to confirm me in the belief that the greater part of the bed of the lake is clay or clay-marl. There may be areas where more or less sand has been deposited upon and covers the clay, and there may be places where peaks of the underlying rock may rise above both the clay bottom and the water itself forming islands in the lake; but these, in my opinion, constitute but a small part of the whole.

"That this deposit of clay is of considerable thickness I infer, from the fact—that wherever there is a current, whether it be near the mouths of the tributary streams (for a greater or less distance before they enter the lake) in channels of the lake itself, or at and below its outlet, I have invariably found in both this and other lakes similarly situated, that the depth of the water in such places greatly exceeds that of the lakes themselves, being rarely less than fifteen and sometimes as much as thirty feet. In order to this, the bed must be composed of material easily excavated and removed by a moderate current of water, and on examination this is almost always found to be clay.

"As regards the fertility and value of the land thus reclaimed, I have no sufficient data to guide me. I am well aware that there may be, and probably is, a great difference in the amount as well as in the kind of organic matter in the sediments deposited in our lakes and in those of Central Europe. I am even inclined to believe that this difference is likely to make in favour of the greater fertility of land reclaimed from lakes in old and densely peopled countries, or in warmer climates, where land and water alike teem with animal life. Still I do not see why the soil should not be as fertile, if not more so, than much of the land in the older parts of Ontario or even in the North-West. This is a question of the first importance, but one notwithstanding, which can only be decided by actual experiment.

"I have already observed that it is by no means improbable that the climate of a wide belt of this northern territory is better adapted for the growth of fall wheat than that of Manitoba, and it is at least possible that the calcareous clay or marl which forms the bed of this, and many other lakes north of the height of land, may prove when properly drained and worked a good wheat soil.

"If this should happily turn out to be the case, or even if the soil and climate be less suited to the growth of wheat, but capable of yielding abundant crops of barley, roots and grass, this land must, beyond doubt or question, become sooner or later of great economic importance and value to the people of this Province.

"Lake Abittibi is situated about five degrees or say three hundred and fifty miles due north of Toronto, and is nearly equi-distant from Toronto and Montreal. It lies to the south of any part of Manitoba or of our North-West territories, and even of some parts of the north shore of Lake Superior. Roughly speaking, this part of the disputed territory is no further from Toronto than Sault Ste. Marie.

"Another important factor in estimating the value of the land that may be thus reclaimed is suggested by the consideration that it will be "cleared land." Wild lands in the older provinces are encumbered with trees and underbrush which must be cut down and burnt up before they can be cultivated at all. This clearing of bush land is itself a laborious and expensive operation, but if the stumps and the roots of the trees have also to be removed, as they must be in order to admit of proper cultivation, and the use of labor saving machinery, the cost is greatly enhanced.

"But the soil of these lake basins when drained will, I apprehend, be not only unencumbered with trees and roots, but absolutely free from noxious weeds, if not also in such a state of tilth as to allow of the seed, grass or grain as most suitable, being at once sown or put into the ground.

"Thus, as compared with the prairie land of the far off North-West, reclaimed land, such as I have described, at or near Lake Abittibi, is, other things equal, much more valuable as being from eight hundred to eighteen hundred miles nearer to the common markets for the produce of both. And as compared with

the wild lands of the older provinces, it is (other things being equal) much more valuable, inasmuch as the soil will be ready for the reception of the seed, and therefore should be worth as much as cleared land in Western Ontario if not elsewhere.

"I shall not enter into any calculation of the expenditure that may be necessary to drain these lakes. That will vary almost indefinitely according to circumstances; and in order to make any even approximately correct or reliable estimates, very careful examinations by competent men would be requisite in each case. I will simply repeat my firm belief, that the cost will be trifling as compared with the value of the land reclaimed.

"I may be too sanguine in regard of the results to be expected from the drainage of the lakes in this territory. But the possibility of being able to drain them and of thus reclaiming, at a moderate cost, such vast areas of land as we find either altogether under water or in the condition of marshes, swamps and muskegs in this northern territory, is a subject, in my opinion, second in importance to no other as bearing on the fitness of the country for settlement and its value not only to the Province of Ontario but to the Dominion at large. It is a subject in which I have felt the deepest interest, and which I have kept more or less in view during all my explorations. It is one, moreover, which has not attracted as yet that attention from engineers and capitalists which I think its importance deserves. For not only in this disputed territory but in many other parts of Ontario and of the older provinces may be found numerous lakes so favorably situated as to admit of their being more or less completely and easily drained, and the drainage of which would be most profitable, even in a financial point of view, if reasonable arrangements could only be made with the governments, and the proprietors of the land f onting upon, or adjacent to, such lakes."

A more careful examination of these lakes the following year fully confirmed the opinions just quoted.

It was found that the three lakes Abittibi, Bank and Nighthawk could all apparently be drained at a very moderate expense and that instead of five hundred square miles the quantity of land thus reclaimed (inclusive of marshes and swamps, otherwise of little or no value) would not be less than one thousand square miles or six hundred and forty thousand acres.

Without going into tedious and unnecessary details it was found as regards the depth of these lakes—that they vary a few feet in that respect according to the season of the year, attaining their greatest height in the months of May and June. This variation in the level of the water—caused by the melting of the snow which has accumulated in the woods during the preceding winter does not apparently amount to more than four or five feet. The result of upward of five hundred soundings taken in all parts of these lakes during the months of July and August (1888) went to show. As regards the upper or easterly division of Lake Abittibi, a mean or average depth of eight feet four inches only. The greatest or maximum depth in the open lake, being fourteen feet.

In the lower section or division of Lake Abittibi, the mean of the soundings taken was nine feet four inches and the maximum depth twelve feet. No soundings were taken near shore, where less than four or five feet in depth.

In the narrows which connect the upper and lower divisions of the lake, and which are about three and a half miles in length, and from five to ten chains in width, one hundred and twelve (112) soundings were taken ing a chan el from twenty-four to fifty-three feet in depth. Between the extreme west end or

outlet of Lower Lake Abittibi and Couchiching Falls, a stretch of about three miles, the depth of the river (Abittibi) was found to be from fourteen to thirty feet, and width from three to four chains.

The fall in the distance of about five hundred yards (the length of the portage) is fifty feet as estimated by the officers of the Geological Survey. About two-thirds of this fall, or say thirty-three feet, occurs in the first one hundred and fifty yards. The reef of rock over which the water of the river is here precipitated, extends a short distance above "the fall," and although the action of the water and ice have worn a channel of sufficient depth to drain the lake to its present level, if it were intended to drain the lake entirely, considerable rock cutting would most likely be required, extending from one hundred to two hundred yards above where the fall begins, and the rock is visible. Nevertheless the conclusion reached by the writer, after this second and more careful examination, was, that the cost of draining this immense lake (if no hidden reefs of rock interpose other and greater obstacles than now appear) will be very small as compared with the value of the enormous tract of land, that would thereby be reclaimed.

The result of the re-examination of Bank Lake and Nighthawk Lake, was not less satisfactory. In order to this the Abittibi River was descended to its junction with Frederick-House River, and from the junction, this last river, which is there about three chains in width, was ascended to Bank Lake, a distance roughly estimated as somewhere between thirty-five and forty miles. The first stretch about nine miles in length, and the last, six miles long, were quite navigable. The intermediate part of the river, however, was found to be a succession of rapids and falls, no fewer than eight "portages" being necessary. The first occurs nine miles from the junction and the eighth and last portage six miles from Bank Lake. This is rendered necessary by one of the finest falls met with by the writer north of the height of land. The river descends at this point sixty feet, if not more in a distance of one hundred and fifty yards. There is no visible sign or appearance of any reef of rock between this fall and Bank Lake. And it is all but certain, that a small amount of work done here would drain Bank Lake if not Nighthawk Lake also. The land on both sides the river from Bank Lake to the falls, a stretch of six miles is possessed of a good soil, but wet or liable to be flooded—as are large tracts bordering on Bank Lake itself, on Nighthawk Lake and the connecting stretch of river between these two lakes. It is thought probable that these were all parts of what may have been originally one large lake. This lake, in a southerly direction from the falls to the south end of Nighthawk Lake (or rather to the foot of the rising ground, still further south) must have been at least twenty-five or thirty miles in length and have averaged in width not less probably than ten miles.

The depth of these lakes, as ascertained by numerous soundings taken in the month of August—is less even than that of Lake Abittibi—ranging from five to ten feet only and averaging about seven feet.

Thus if drained—as these lakes and the adjacent low lying country certainly can be drained—by a very inconsiderable outlay at the falls—not less than two hundred and fifty square miles of land would, it is believed, be reclaimed.

There are known to the writer many other lakes in provincial territory which may be drained with equal facility and afford when they are drained, large areas of arable ground—which cannot fail to prove sooner or later, in his opinion, of the greatest value and importance.

Enough, however, has now been said to show, that, as respects some of the lakes at least, the submerged land which forms their beds is worth much more than the water.

It will now be in order to show under the next head that as regards other lakes, the water may be more valuable than the basins in which it reposes.

It is as an unfailing and almost unlimited source of water-power that these lakes and streams are, in my opinion, of the greatest importance and value.

Before proceeding further to discuss this question, however, it is absolutely necessary to say somewhat in reference to the education, training and experience which may be supposed to qualify the writer to report upon this particular subject with a degree of authority, to which simply as a stipendiary magistrate, miner or explorer, he could make no pretension whatever. In order to do this he respectfully submits the following narrative:

My father, the late John Arthur Borron, of Woolden Hall, Lancashire, was a man of exceptional ability and great general information, and extensively engaged in agricultural, manufacturing and mining enterprises, which were carried on partly on his own account and partly in partnership with others. Among these may be mentioned the cultivation of a part of his own property, the reclamation of a portion of Chat Moss, glass making in Warrington, cotton spinning and weaving near Manchester, salt making at Anderton, Cheshire, and coal mining in Staffordshire. In addition which he had for a number of years the general management of the two principal lead mines in Scotland, namely, those at Leadhills carried on by the Scots Mines Company, under a 99 years lease from the Earl of Hopetoun. The other at Wanlockhead carried on by the Marquis of Bute under a long lease from the Duke of Buccleuch. These mines which were contiguous, though in different counties, had both been worked without intermission, it is believed, for more than two hundred years. The richest veins had consequently been sunk upon to depths which rendered the drainage of the mines and hauling of the ores to the surface both difficult and expensive.

That part of Scotland is broken and mountainous—indeed the villages of Wanlockhead and Leadhills are generally considered to be the highest in Scotland. The old miners had taken advantage of this physical feature and drained many of the veins to a considerable depth by what are called "Adit levels," which starting from lower ground were carried along the veins (and sometimes for long distances at right angles thereto) with just sufficient inclination to allow the water of the veins when intersecting to run off. Many miles of such adit levels had been driven not unfrequently in hard slate rock. Where the veins were richest the ore had been stopped or worked out to a limited depth below these adit levels, rude hand-pumps having been used to keep down the water.

Later on water wheels (breast and overshot) were erected to work the pumps. The water required to drive these wheels was brought in water courses (aqueducts) from burns or small streams in the adjacent glens or valleys.

Later still, or about the end of last century, several powerful steam engines, locally called "fire engines," were erected to drain some of the richest and deepest mines. These engines, although doubtless as good as could then be obtained, consumed enormous quantities of coal. Although this coal could be got at points no further away than fifteen miles—so primitive were the coal mines, and so steep and rough the roads in those days, that the cost of the coal laid down at the mines was very high. In some instances it had to be carried to the mines, I believe, on pack-horses. Notwithstanding this heavy expense for drainage, large profits were realized by both for many years. Some time, however, prior to 1827 or 1828 the mines had become not only poorer, deeper and more difficult to work, but the price of lead had fallen very greatly.

In consequence of this and of mismanagement otherwise both mines were then working at a loss, and a total suspension of operations was seriously contemplated.

This was the condition of affairs when my father, whose advice and assistance had been asked, was intrusted with the general management. His other numerous business engagements only permitted him to visit and spend a few days at the mines every three months, but he was ably assisted at Wanlockhead by the late James Stewart who succeeded him as manager, and by a brother some ten years older than myself at Leadhills, both of whom resided permanently on the spot.

It was only by the substitution of machinery for manual labor and of water-power for the more costly steam-power required to drive this machinery that these Scottish mines could be profitably worked. This my father was quick to perceive and prompt to act upon. Thereafter every drop of water was utilized with the result that the mines instead of stopping as was threatened, at the period referred to, have been working with fairly good results, I believe, ever since. Thus it came that the great value and importance of water-power were deeply impressed on my mind by my father at a very early age.

My education, designed to prepare me for mining and mining engineering pursuits, was never entirly completed. Commenced and carried on for the first few years at Mytholme Academy, Lancashire, under the Rev. Peter Steel Dale, it was continued at Bruce's Academy at Newcastle-upon Tyne, where the celebrated civil engineer, Robert Stephenson, had some fifteen or sixteen years before obtained his school education. This was one of the very few schools or academies in England in which at that time science was taught, and to the lectures and teachings of Dr. Bruce on such subjects as chemistry, geology, mechanics and physiology I am chiefly indebted for such knowledge as I acquired in my youth. My scholastic education ended with a single term at the University of Edinburgh, from which, owing to a long and severe illness, but little benefit was derived.

Withdrawn from college at the early age of fifteen I assisted my father for several years in connection with the mines in which he was interested as manager or otherwise. For a short time in the Island of Islay, then at Strontian in Argyleshire where he was engaged in mining operations on his own account; and subsequently at Tyndrum in Perthshire as assistant manager under my father for the Marquis of Breadalbane. At both these last mentioned mines all the available water and water-powers were utilized for driving the necessary machinery. In 1838 I resigned my position at Tyndrum and went to Leadhills to asssist my brother William Geddes Borron then managing partner of the Scots Mines Company's mines. He soon after bought out his partners, and on his removal to Glasgow a few years later I became resident manager of the mines, a position which I held from 1842 until the year 1850, and again from the year 1858 to 1861. The intervening eight years having been spent in the United States and Canada principally at the Bruce Mines, of which I had, as may be seen in the report of the Mining Commission, the general management for six years. In this report will be found also a brief record of my subsequent experience in connection with the mines and minerals of this Province.

At Leadhills, as formerly explained, it was absolutely necessary to make the best possible use of the water and water-power afforded by the neighboring burns or streams.

Many miles of watercourses, mostly on the surface, but partly subterranean conveyed the water to the water wheels and hydraulic engines, known variously by the names of water-pressure or reciprocating engines. These water-pressure engines were employed both in pumping and in hauling up the ore, and those at Wanlockhead mines, when under my father's management, were the first of the kind erected in Scotland.

So vitally important, if not absolutely indispensable, was this water-power to the successful working of the mines at Leadhills that, several years before I went there as assistant manager, disputes had arisen between the lessees of the different mines in regard to their respective rights to the water of a small stream called the "Shortcleugh-Water," and to the watercourses connected therewith. In these disputes the landlord or proprietor, Lord Hopetoun, soon became involved. They resulted eventually in a lawsuit, than which it is questionable if any case, in regard to water and water-rights has ever been so obstinately contested before the Scotch courts. Commenced in 1836 it was continued with little intermission from that time until my departure for America in 1850.

Returning to take the management of the mines again in 1858 the suit was still going on with three or four others to which it had in the meantime given birth, and was only terminated at last by a compromise in 1861.

This bitter struggle, for the right to possess and use a stream of water which any active boy could easily jump over, lasted twenty-five years, was several times before the House of Lords, and must have cost the parties thereto not less than one hundred thousand dollars in law expenses alone.

And yet so valuable was it as water-power that the party who kept possession of the water during all these long years considered himself, it is said, amply repaid for all that it had cost him.

This long personal narrative my be thought uncalled for and in bad taste. Too long it may be. Some particulars perhaps might have been omitted with advantage, if not with propriety, but as stated at the beginning, it is absolutely necessary that the writer of such a report as this should be able to show his competency to deal intelligently with the matters to which it relates, or in other words that he is what is called in this country "an expert." This is the sole object of it, and this must be his apology, if such be needed. It shows that his attention has been for many years very earnestly directed to the nature, value and importance of water and water-powers, as well as to the best means of applying or utilizing the same. And that, whether in respect of early training, education or experience, he may not unreasonably claim to be as good an authority on this subject as the Government can easily find.

But in addition to this general competency to judge, he may, in view of his explorations in Provincial territory during the last thirty years, reasonably claim to have had better opportunities of forming trustworthy and reliable opinions on this interesting and important subject than any other man in Canada, with the single exception, perhaps, of Dr. Bell, Assistant Director of the Geological Survey of Canada.

Having thus shown my title to be considered a fairly competent authority, and that I have also had exceptionally good opportunities of seeing, if not knowing, much that it is needful should be seen and known upon the subject, it is now desirable, if not imperatively necessary, that I should place in as strong a light as possible the vast and overwhelming importance of "power."

In attempting to point out the great and rapidly increasing importance of "power in general" to mankind, I wish it to be understood that the word "power" as thus used is not intended to apply to or include "muscular power," which not only man but every living creature possesses in a greater or less degree, but to the "working power" (sometimes called mechanical) afforded by other "physical forces," more particularly gravitation and heat, and which may be directly or indirectly obtained from water, wind and fuel or steam, and substituted for muscular-power, or labor of men and animals.

A few generations ago and nearly every kind of employment or industry was carried on by hand, or by what is commonly called manual labor. In agriculture the use of steam power and of labor-saving machinery is of comparatively recent date. Some of us can even remember the time when the farmer very literally "earned his bread by the sweat of his brow." When grain was cut with reaping hooks and threshed out with flails. A time when although corn might not, as of old, be pounded in mortars, was, nevertheless, ground in mills of the most primitive description.

Now, steam ploughs, mowing machines, reapers and binders, threshing machines and other implements unknown to our grandfathers no only lighten the labor of the farmer but enable him, at much less expense than formerly, to raise the food so necessary for our support.

In manufacturing industries there was 150 years ago little that could be really called machinery in use, and what there might be was almost invariably put in motion by the muscular power of man, or of the animals he had domesticated. It is true that rude water-wheels and windmills were not unknown centuries ago, but the use of such was confined to a few employments, and in these was far from general.

The operations of carding, spinning and weaving of cotton, wool, flax, etc., into what are called "textile fabrics" were nearly all performed by hand when my father was born. And sixty years later, in Lancashire and Yorkshire, the seats of the great cotton and woollen industries of England, there were still many families who made their living by hand-loom weaving, as I can myself remember.

Now, what with steam engines and water-engines to supply "the power," and machinery to do the work, manual dexterity and bodily labor have been in a great measure dispensed with.

Such labor as may still be necessary is also of a much lighter character than formerly, consisting chiefly of what is called "minding the machinery." At the same time this labor—light as it may be—is much more efficient. Each person now employed in our factories is able to manufacture many times the quantity of cloth that it was possible for the most skilful and vigorous hand-loom weaver to do, toil at his loom as he might from early morning until late at night.

In mining the work was formerly done almost entirely by men and boys sometimes by women. Now, power for driving labor-saving machinery is employed in every department of mining work, for draining the mine, excavating and hoisting the ores, for crushing, stamping and dressing them, and finally in smelting them, where such is done in blast furnaces. Nor is it less important in regard of transportation, whether it be of materials and stores required at the mine, or of the produce thereof when sent to distant markets.

Again, in the working of metals into such things as are useful to mankind, a multitude of articles, from pins and needles, nails and screws, to anchors and engine shafts, formerly made entirely by hand, are now manufactured almost entirely by machinery. The same may be said of wood-work and the products of clay, such as bricks, tiles, etc., both largely employed in the construction of our dwellings.

Even in the most common occupations and employments, machinery impelled by steam or other motive power, has either superseded or greatly diminished the necessity for that excessive bodily labor or drudgery which many mechanics, tradesmen and artisans had previously to undergo. The work of the shoemaker, tailor, dressmaker, of the cooper, carpenter and blacksmith, of the mason,

machinist, printer, paper manufacturers and scores of others too numerous to mention, is now (as almost every one knows) performed in a great measure by machinery.

But in nothing, perhaps, has the substitution of steam power for the labor of man and animals been so important or so fraught with blessings as in the matter of transportation. The speed, ease and comfort, even luxury, with which it is possible now to travel from place to place; or, if desired, around the world, by means of locomotives and steamships, is in striking contrast to the protracted toil and hardship—if not positive danger to life—incurred by our ancestors when compelled to undertake journeys of even moderate length. Nor is it possible to over-estimate the importance and value of railways, in regard of the facilities they afford for the distribution and exchange of the products of the soil, the mine, the forest and the sea, as well as of the factory and the mill. Indeed, it is not easy to name any discovery or application of power—that has done so much to develop, not merely the resources of a few countries, but of the world at large—that has done so much to encourage trade, commerce and personal intercourse between individuals, communities and nations; that has done so much to increase knowledge, remove prejudices and to promote the comfort, welfare and happiness of mankind generally. And yet this great railway system is, so to speak, a thing of yesterday. It may be said to have been inaugurated only when the Liverpool and Manchester railway was formally opened, an event of which the writer—standing by his father's side on Chat Moss in the year 1830—was an eye witness.

Finally, in its relation to light, heat and electricity, it has now been satisfactorily proved that power, force or energy (as it is variously named) may be transmuted or changed into any or all of these, not merely as an experiment in a class-room or a laboratory, but on a large and practical scale. Thus "power" as a means of obtaining light, heat and electricity, is in this respect also becoming of the greatest economic value and importance.

The fact that "power" can be converted into electricity, transmitted in that form over a cable, a considerable distance, and then and there reconverted into power again, is one of the very greatest significance and importance, as will be pointed out hereafter, in connection with the utility and value of the water powers of our province. This brief retrospect or survey shows, or is intended to show, that whether in agriculture, mining, manufacturing, indeed all industries which have for their object the supplying of mankind with the necessaries, conveniences and comforts of life, the wonderful progress that has been made in this century is chiefly due: 1st. To the general substitution of the great physical forces or "motive powers" for the much *more costly* "muscular power" of men and animals. 2nd. To the invention of power-looms and other quick-working, untiring and in a great measure self-acting machines, and their substitution for the slower, more uncertain movements of the oft-times wearied hands of the artisan, however dexterous. 3rd. To what is known as the division of labour, which has been brought about, in a great measure, by this general employment of steam, water power and of machinery for the muscular power and manual dexterity of men, women and children.

And the conclusion to which it is desired to lead is that *power*, intelligently directed to the working of suitable machinery, is really and truly the principal factor in the wonderful progress to which allusion has been made under this head, and hence the overwhelming importance of cheap and abundant "power" to the Province of Ontario.

Sources of Power.

Our enquiry now leads us up to the sources of the motive-powers, on which so much has been shown to depend, and without which, no manufacturing industries in the modern sense of the term, can be successfully carried on, in this or any other country, where labor is properly rewarded, and the rights and liberties of consumers respected.

The immediate sources of the power employed at the present day to drive, as it is called, machinery, are: 1st, steam; 2nd, water; 3rd, wind. The primary source of the force or "potential energy" in all three powers being the sun. Taking these in the order given, we have, 1st, steam. The vast importance of the steam-engine, and the great factor it has been in the growth of manufacturing industries, and in the progress of the principal nations in wealth and civilization; the principles on which it depends, and the manner in which it acts, are all so universally acknowledged and understood, that little need be said here on that subject. It might, without any great impropriety, be called "fuel-power," inasmuch as it is "the fuel" which really supplies the "heat or power" which is utilized by the aid of the steam-engine. Its value for manufacturing and other purposes in any particular country or at any particular point, depends almost entirely on the abundance and the cost of fuel. Hence those countries where fuel is cheapest are the most favorably situated in respect of this great power.

2. Water.—The origin of water power, and the manner in which it acts, can be most readily explained by reference to a clock in which weights are employed. These weights having been wound up by an expenditure of muscular power, sufficient to overcome the force of gravitation, are no sooner liberated, than they begin to descend under the influence of that same mysterious force and in descending give motion to the works. When at the end of eight days or so, the weights have "run down," the amount of power expended in keeping the clock going, is equal, making due allowance for friction, to that exerted in winding them up. In like manner the sun raises water in the state vapour from the ocean, and overcoming the force of gravitation which we call "the weight," deposits the same in the form of rain or snow on some far off plateau or range of mountains, hundreds and sometimes thousands of feet above the level of the sea. As in the case of the weights of the clock when fully wound up, there is in every gallon of this water a certain amount of "latent power" which scientists call "potential energy." This varies, it will be readily understood, according to the height of the land on which it has been deposited.

The "potential energy" in a given quantity of water elevated a thousand feet in height, being ten times as much as that in a like quantity of water, raised one hundred feet only above the level of the sea. This water, like the weights of the clock, in descending by force of gravitation to the sea, can, under favourable circumstances, be made to communicate the greater part of its "potential energy" or power, to water-wheels, turbines or other hydraulic engines, and employed in driving machinery for manufacturing or other purposes.

3. Wind.—The "potential energy" of the wind is probably far greater than that of any other source from which, what we call "power" is obtained.

In navigation, the force of the wind has been utilized from time immemorial, to the present moment, with infinite advantage to mankind. It will be thus employed in all probability, long after steam, owing to the scarcity and dearness of fuel, has ceased to be thus applied. For pumping water too, it has been in times past, and still is exceedingly useful, whether the water be pumped from

wells for domestic use, from rivers for the purpose of irrigation, or in order to the drainage and reclamation of valuable tracts of land. Wind-mills have been largely employed in the grinding of wheat and other grains into flour, more especially where good water power has not been available. The fact that a constant power was not absolutely necessary for this, and some other purposes, coupled with the circumstance, that those who erected and worked them, were more familiar perhaps with wind-mills than water wheels, has led to their frequent employment in Canada, and that even in the Province of Ontario, so favorably situated in regard of water power.

Sometimes the difficulty and expense, if not impossibility of getting water-power exactly were wanted, may (as will be fully shown hereafter) have led to the employment of this or other means of obtaining power.

It is a somewhat singular circumstance and one only to be accounted for in some such way as here suggested, that forty years ago there was still standing "a wind-mill" at Sault Ste. Marie, within sight of one of the finest water powers on the continent!

For manufacturing and other important purposes, which require a steady and reliable power, wind mills are now I think rarely if ever used. The fickleness and uncertainty of the wind is proverbial. For days, if not weeks, the atmosphere may be so calm, or the wind so light as to be incapable of supplying sufficient power to drive the machinery, and thus occasion great loss and inconvenience, especially where a large number of hands were employed.

It is possible or even probable that the ingenuity of man may yet devise some scheme or plan, by means of which the excess of energy in the wind at one time or during one period may be stored up, and this "store" drawn upon as needed during those periods, when the power afforded is insufficient, and thus that steadiness and constancy ensured, which is one of the most valuable characteristics and advantages of steam power and also good water power.

In view of this, as yet fatal objection to the employment of wind power in manufactories and mills, the opinions I am about to advance in reference to Ontario's position in regard of power, will be confined to the only two, at present available, namely, "steam power" and "water power."

The Position of Ontario in regard of Steam Power.

As an all-round, useful engine, one that can be obtained of any power, applied to any purpose, stationary or locomotive, on land or water, and in any part of the known world with the exception of the Arctic regions or the great deserts, the steam engine surpasses all other.

The great improvements in the steam engine made by Watt and others certainly "paved the way" for that substitution of power for manual labor, which may be said to have commenced only at that time, and has gone on with such surprising rapidity ever since. But for the steam engine—notwithstanding the discoveries of Arkwright and others—it may be confidently asserted that there would have been very few cotton or other factories in my native county, Lancashire, now a "very hive" in regard of that and other most important industries. They would have been restricted to the few spots whereat water power was obtainable. And the number of such, and the power available thereat are both very limited.

The following extract from Green's Short History of the English People, showing the condition of manufactures in the mother country one hundred years

ago, throws some interesting light on this and other parts of the subject dealt with in this report. On pp. 791 and 792 the historian says:—"Though England already stood in the first rank of commercial States at the accession of George the Third, her industrial life at home was mainly agricultural.

"The wool trade had gradually established itself in Norfolk, the West Riding of Yorkshire, and the counties of the South-west, while the manufacture of cotton was still almost limited to Manchester and Bolton, and remained so unimportant that in the middle of the eighteenth century the export of cotton goods hardly reached the value of fifty thousand a year. There was the same slow and steady progress in the linen trade of Belfast and Dundee and the silks of Spitalfields. The processes of manufacture were too rude to allow any large increase of production. It was only where a stream gave force to turn a mill wheel that the wool worker could establish his factory; and cotton was as yet spun by hand in the cottages, the "spinsters" of the family sitting with their distaffs round the weavers handloom. But had the process of manufacture been more efficient, they would have been rendered useless by the want of cheap and easy means of transport. The older main roads which had lasted fairly through the middle ages had broken down in later times before the growth of traffic and the increase of waggons and carriages. The new lines of trade lay often along mere country lanes which had never been more than horse tracks. Much of the woollen trade had to be carried on by means of pack-horses and in the case of yet heavier goods, such as coal, distribution was almost impracticable save along the greater rivers or in districts accessible from the sea. A new era began when the engineering genius of Brindley joined Manchester with its port of Liverpool in 1767 by a canal which crossed the Irwell on a lofty aqueduct, the success of the experiment soon led to the universal introduction of water carriages, and Great Britain was traversed in every direction by three thousand miles of navigable canals. At the same time a new importance was given to the coal which lay beneath the soil of England. The stores of iron which had lain side by side with it in the northern counties, had lain there unworked through the scarcity of wood, which was looked upon as the only fuel by which it could be smelted. In the middle of the eighteenth century a process for smelting iron with coal turned out to be effective, and the whole aspect of the iron trade was at once revolutionized. Iron was to become the working material of the modern world, and it is its production of iron, which more than all else, has placed England at the head of industrial Europe. The value of coal as a means of producing mechanical force was revealed in the discovery by which Watt in 1765 transformed the steam engine from a mere toy into the most wonderful instrument which human industry has ever had at its command. The invention came at the moment when the existing supply of manual labor could no longer cope with the demands of the manufacturers. Three successive inventions in twelve years, that of the "spinning jenny" in 1764 by the weaver Hargreaves, of the "spinning machine" 1768 by the barber Arkwright, of the "mule" by the weaver Crompton in 1776, were followed by the discovery of the "power loom." But these would have been comparatively useless had it not been for the revelation of a new and inexhaustible labor, force in the steam engine.

"It was the combination of such a force with such means of applying it that enabled Britain during the terrible years of her struggle with France and Napoleon, to all but monopolize the woollen and cotton trades, and raised her into the greatest manufacturing country that the world had seen."

As stated elsewhere, the cost of steam power depends almost entirely on the price of the fuel required to produce it, at the time and in the place where the

power is wanted. The conditions in this respect may be such as entirely to preclude, or greatly limit the employment of steam power. It is important therefore at this stage of our enquiry to look into this question a little and see how Ontario is situated, or likely in the future to be situated, in regard of fuel.

The fuels available for steam-raising purposes are, 1st wood, 2nd peat, 3rd lignite, and 4th coal.

Wood has in times past been very largely employed on this continent for raising steam, but the consumption for this purpose is becoming less every year. As settlement advances, and the land is cleared and brought under cultivation, the forests are rapidly disappearing. In thus clearing the land, much of the timber has been hitherto burnt on the ground, in order to get rid of it; where it was wanted either for steam or other purposes, it has been sold. The price, however, of this fuel, commonly known as "cordwood," has increased as the areas of timbered land have diminished in number and extent, and with the increasing distance to which it has been necessary to haul it. In most of our cities and towns the price of cordwood is already so high as to preclude its use for steam-raising purposes. And the probability is that in a short time wood will cease to be used for other than building manufacturing and the most urgent domestic purposes in all parts of the province.

Peat.—This fuel has been found by the writer in practically inexhaustible quantity in the provincial territory lying north of the height of land and south of James' Bay. (See reports of Stipendiary Magistrates for 1881, pp. 11 *et seq.*)

That these great deposits of peat will sooner or later prove of inestimable value as fuel the writer still firmly believes. But in the absence of cheaper rates of transport than are obtainable under our present railway system, the distance of these peat mosses from the chief centres of population in Ontario is such as almost to preclude the hope of its ever becoming a cheap fuel for manufacturing or steam-raising purposes in the southern parts of the province. It will be shown, however, under another head (later on), that with cheaper means of transport than is afforded by ordinary railways, and which the writer believes not only possible but already almost in sight, the great deposits of peat and of lignite also found in this territory, may yet be utilized for many important purposes, not only on or near the spot, but in every part of the province.

Lignite, or Brown Coal.—This fuel (as just observed) has been discovered in provincial territory, north of the height of land, on th Abittibi, Mattagami, and Missinaibi branches of Moose River. The full extent of these deposits or beds has not been ascertained. But, however extensive, in the absence of cheaper means of transport than afforded by ordinary railways, it cannot be mined and laid down in Toronto or Hamilton at such a low price as will make it desirable for steam-raising purposes.

Coal.—There is in the opinion of geologists no true coal in the Province of Ontario. For coal, whether hard (anthracite) or soft (bituminous), we are dependent on the Maritime Provinces and the United States.

The distance from the Maritime Provinces of Nova Scotia and New Brunswick is such as leaves little room for the expectation that coal can ever be obtained from thence at other than a high price. The coal fields of the United States are much nearer, and from thence coal can be imported and laid down in the principal towns and cities of Ontario at an average price probably of five dollars ($5.00) per ton of 2,000 lbs. The price of coal for steam-raising purposes in the great manufacturing centres of England and Scotland is not more than two dollars, and it is only a little more, I imagine, in those of the United States.

Thus it will be seen that in respect of fuel, and consequently of steam-power, Ontario occupies on this continent a very unfavorable, one might say "unenviable," position, as compared with the Maritime Provinces and British Columbia, and with many if not most parts of the United States, and still worse as compared with England, Belgium, and other great manufacturing countries in Europe. As was well said in the "Monetary Times" a few days ago: "Ontario has to import her motive power, and the Dominion commits the folly of taxing it." To which might have been added, "with the possibility of being denied even that poor privilege should at any time commercial intercourse with our neighbors to the south be suspended or interrupted."

The Position of Ontario in regard of Water Power.

The question which now arises, and it is a very momentous question in its bearing on the future of our province, is how are the people of Ontario situated in regard of the only remaining source of power—water-power?

And the reply is, that in the opinion of the writer no people in the world sufficiently advanced in civilization to be capable of utilizing this bounty of nature is more signally blessed in this respect than the people of Canada, and no province of Canada so highly favored as Ontario; and that he believes the Province of Quebec (which has also no coal) will come next in this important particular, although the streams and rivers of British Columbia (which he has not yet visited) unquestionably afford an enormous amount of water-power.

Valuable as steam-power is for almost every purpose, and indispensable as it is for some, it is not only equalled but excelled for manufacturing and many other important purposes by really good water-power.

Water-power (if good) costs little or nothing, except the interest on the first outlay for intake-lades or watercourses and tail races, and for wheels, turbines, or other hydraulic engines, together with the cost of such slight repairs as may be needed from time to time.

Hydraulic engines require no skilled engineers, no firemen, no fuel. They afford a cheaper power than the steam-engine even if the fuel required for the latter could be obtained for nothing. If any proof of this be wanted, I need only refer to the fact that even in those parts of Great Britain where coal is the cheapest, good water-powers are not only employed in mining, manufacturing and other industries, but they command considerable prices in the form of rent. For instance, in the town of Greenock, Scotland, where coal for steam purposes could at the time referred to be bought for one and a half or at most two dollars a ton, the corporation some years ago received for water-power in the outskirts of the town, and used for manufacturing purposes, a yearly rental ranging from $8.40 to $20.40 per horse-power, the use thereof being restricted to 12½ hours per day. If further proof of the superiority of water-power to steam-power be required, we have only to look at the United States to be convinced, for we shall there see that many of the largest and most successful factories and mills of our enterprising neighbors are driven by water-power. In short, really good water-power is the best and cheapest power known to us, and one of nature's richest gifts to her children.

The country lying to the north of Lakes Superior and Huron, and to some extent also of Lake Ontario, abounds, as is well known, with lakes. So numerous indeed are they on the plateaus north and west of the first mentioned great lake, that one-third of the whole area has been roughly estimated to be covered

with water. In these lakes, situated 1,000 feet and upwards above the level of the sea, most of the streams and rivers, whether flowing southward and eastward into the great lakes, or northward into James' Bay, have their source or origin.

Varying as they do from a few hundred yards to fifty or more miles in length, these lakes form the most magnificent "natural reservoirs" perhaps in the world, and render the costly artificial reservoirs, compensation ponds and mill-dams generally required elsewhere, entirely unnecessary. In these lakes, or natural reservoirs prodigious quantities of water are stored up (so to speak) in the spring and fall, to be gradually given off during the drier seasons of the year. At comparatively little expense most of them might be rendered so complete that the water powers situated on the streams and rivers issuing and descending therefrom would be not only unfailing, but steady and reliable at all seasons of the year.

Without this wonderful net-work of lakes, the water-powers on most of these rivers would have been frequently either unmanageable on account of floods, or so uncertain and irregular in times of drought as to be almost if not altogether useless for manufacturing purposes. This is one of the reasons why the streams and rivers in the greater portion of the United States, and many of the principal countries of Europe, afford so few really good water-powers. At some seasons roaring torrents overflowing their banks and carrying everything before them; at other times almost dry; such streams and rivers cannot afford good and reliable water power. In America the cutting down of the forests, and in Europe that and the under-draining of the land have tended to aggravate these evils, and streams which at one time furnished power to drive mills are now entirely useless for that purpose.

It is not pretended that our Canadian streams and rivers are not liable, at any time or under any circumstances, to such fluctuations. Most of them, during what are called the spring freshets, caused by the melting of the snow which has fallen and accumulated on the ground the preceding winter, rise considerably, and are at other times more or less affected by prolonged spells of wet or dry weather. Frost and ice, too, may be the cause of more or less trouble during winter. All that we claim is, that owing to the occurrence of lakes, either at their immediate source, or as "chains" on the rivers themselves in their after course (frequently both), our streams and rivers are not nearly so liable to the extreme fluctuations which characterize those of other countries. And further that by means of "dams" or "weirs" provided with "sluices" placed at or near the outlets of these lakes, the fluctuations in question can be greatly lessened and not unfrequently entirely remedied. Thus at a trifling outlay as compared with other countries the water in our streams and rivers can be controlled and regulated, and that "steadiness of supply" insured which is essentially necessary in all good water-powers, and one of the principal factors in estimating their value.

In confirmation of this opinion, which will be endorsed, I venture to believe by every practical man at all conversant with the subject, I may quote from the article on "Water Power" in Chambers' Encyclopædia, wherein it is said "the value of water power depends much on the nature of the source of supply, whether steady or otherwise. Where streams supplying water-power are liable to fall off much in dry weather large impounding reservoirs are necessary to keep the mills from being stopped during summer. These, however, being generally expensive concerns, are seldom made for one mill, but rather by some association of mill-owners, and often by a water company or commission, for supplying a town with water to afford compensation to the mills by storing up flood water for what is abstracted for the use of the town."

From what has now been said, it will be seen that the superiority of our water-powers to those of other countries is due primarily to the great number of lakes in Canada generally, and especially in our own Province of Ontario. Thus bearing out the assertion of the writer at the beginning of this report, "that it is as an unfailing source of almost unlimited power that these lakes and streams are, in his opinion, of the greatest importance and value." In the words just quoted from Chambers "as large *impounding reservoirs* necessary to keep the mills from being stopped during summer," these lakes will sooner or later be worth millions of dollars to the people of Ontario.

To convey some idea of the prodigious amount of water power in the province, a rough estimate may be given of "the potential energy" of the water which is precipitated on the height of land plateau alone. This plateau, from the eastern boundary of the province north of the head of Lake Temiscamigue in a north-westerly direction to Lake St. Joseph, may be roughly estimated at about 500 miles in length, with an average breadth of seventy miles, and an area of about thirty-five thousand square miles. The height varies from one thousand to fourteen or fifteen hundred feet above the level of the sea, and will average in my opinion about 1,100 feet, or say 500 feet above lakes Huron and Superior. Assuming the quantity of water precipitated in the form of rain and snow on this plateau, in the course of a year to be thirty inches, it will amount to no less than two and one-sixth millons (short) tons, on each square mile. Say in rouud numbers however two millions tons.

To raise two million tons of water from the level of the ocean to the height of this plateau, or 1,100 feet above the sea, would require 253 66-100 horses, working twenty-four hours a day and 365 days in the year. Multiplying this by 35,000—the number of square miles in the whole plateau—we find that a force equal to that of 8,878,100 horses exerted continuously, is expended in raising or lifting up the water precipitated annually on this height of land plateau. But as horses cannot work continuously more than eight hours we must multiply this number by three, and thus obtain 26,634,300 as the number of horses that would be really necessary for this purpose. Assuming further that six men are equal in power to one horse, it will be seen that the labor of nearly one hundred and sixty millions of men would be required. This is the power expended by the sun in lifting, so to speak, this water from the ocean and depositing it on the height of land plateau. This too is the measure of the "potential energy" *that water* has acquired, and which it will give oft on its descent or return to the sea. In estimating, however, the "working power" that may be obtained from this water, very large deductions have to be made, as will hereafter appear.

Prodigious as this working power unquestionably is, it forms, however, only a part, and by no means a large part of the practically unlimited water-power belonging to the province. There is another extensive tract of high ground, a plateau similar in its physical feature to that last mentioned in the westerly part of Ontario. This is situated between Lake Superior and Nepigon on the east and Lake Winnipeg and the Red River, or rather the prairie bordering that river, on the west. This plateau is partly in the United States and partly in Manitoba. That portion of it in Ontario is bounded on the south by the International boundary from Pigeon River to the outlet of the Lake of the Woods or Rat Portage, and on the west and north by English River, Lac Seul or Lonely Lake, Lake St. Joseph and the height of land plateau, of which it is really a south-westerly tongue or extension. The general elevation is, I believe, about the same, and like it, it abounds with lakes. The area of that part which falls to the share of Ontario, and the potential energy of the water are probably

not much less then these of the northern height of land plateau; but owing to the circumstances of the divide or water-parting being so near to Lake Superior, the far greater portion of the water flows westward into Lake Winnipeg. Thus although there are many fine water-powers in the district, and in the aggregate, a very large amount of power. Manitoba gets, I think, the greater share of it. The water-powers afforded by the Kaministiquia River and its tributaries, by Nepigon River and others, which have their sources in the lakes on the eastern portion of this plateau, can hardly be surpassed for excellence.

A third very important area in this connection and abounding in lakes and rivers, is that laying between the Georgian Bay, Lake Ontario, and the St Lawrence on the one hand, and the Ottawa River, from the head of Lake Temiscamigue to the interprovincial boundary on the other.

This tract contains Lakes Wahapitaping, Temagaming, Nipissing, Whitefish, the Muskoka lakes, Lake Simcoe and many others too numerous to mention. Among the streams and rivers we find the Temagaming, Sturgeon, French, Wehnapita, Maganetawan, Muskoka and Severn, the waters of which, contributed largely by lakes, flow into the Georgian Bay. Of these flowing into Lake Ontario and the St. Lawrence, the River Trent, with its chain of lakes, is perhaps the only one of great importance in regard of its water-power.

On the north side of this tongue of land we have the Montreal River, its waters, contributed by a large number of lakes, some of which are situated on the height of land plateau, flowing into Lake Temiscamingue, and the Mattawa, Petawawa, Bonnechere, Madawaska, Mississippi, Rideau and Nation Rivers, which pour their waters into the Ottawa River. My knowledge of this tract, from actual exploration, is mostly confined to that portion of it lying north of the Mattawa River on the one hand and of French River on the other, inclusive of Lake Nipissing. From what I have seen and heard however, I believe that all these rivers almost without exception either have their sources in lakes or pass through lakes in their after course, and that they abound in falls, cascades and rapids. The average elevation of this portion of the province may be somewhat lower than the northerly and westerly plateaus previously described, but I have no doubt whatever that it affords water-power of great excellence and such as in the aggregate would be considered immense in any other country.

Again on both sides of the height of land plateau, but especially on the northern slope, there are belts of country, together, at least, equal in area to the plateau itself. In passing through these belts, whether it be to Lakes Superior or Huron on the south or James' Bay to the north, all those rivers which have their source in the lakes on the height of land plateau are joined by numerous streams, brooks and rivulets, the water contained in which has been precipitated on these lower-lying belts, and greatly increases the size and power of the main rivers. In fact the rivers rnnning northward into James' Bay are frequently doubled in volume by the time they reached the so called long portages, where most of them descend suddenly upwards of 300 feet in a few miles, affording an enormous amount of water-power.

The belt on the south side of the height of land plateau is comparative narrow, but nevertheless contributes in the aggregate a great quantity of water to the larger rivers which descend from the plateau above, and such additions of course, thereafter, increase their power. In both these belts, too, there are numerous lakes, though not so numerous as on the plateau itself, which are the source of a great many smaller rivers and streams. Those in the northern intermediate belt almost always unite with the large rivers before they reach James'

Bay. Those in southern belt often flow directly into Lake Huron and Lake Superior and frequently afford excellent water-powers for a limited number of mills or factories.

But in addition to all this "wealth of power" within her own territory Ontario shares with the United States the magnificent and unfailing water-power afforded by the rapids at Sault Ste. Marie, with Lake Superior, 32,000 square miles in area, for a reservior and source of supply. And the still more tremendous power of the famous Falls of Niagara, over which is precipitated in one jump of some 160 feet in perpendicular depth, all the water, not only of Lake Superior but of Lake Huron, Lake Michigan and Lake Erie, the aggregate area of which is estimated to be not less than 87,400 square miles. When we consider the amount of water precipitated annually on the surface of these great lakes and on an equal if not greater area of land, the waters of which are tributary thereto, and that the descent in the fall and rapids above and below "the falls" is in all about 330 feet. The magnitude of this power is as wonderful, if not more so, to those who can understand and appreciate its economic importance and value in the not very distant future, as to those who are moved only by the grandeur of the scenery.

The rapids on the St. Lawrence, which occur at various points between Kingston and Lake St. Francis are also capable of affording a very large amount of power, the enormous quantity of water which issues from the Niagara River being still further increased by that furnished by Lake Ontario. Finally, Ontario shares with her sister Province Quebec the fine water-powers afforded by the Ottawa River from Lake Temiscamingue to where it is intersected by the interprovincial boundary line, a short distance from Montreal.

Thus it will be seen that not merely as a figure of speech, but as *a matter of fact*, the water-power of Ontario is almost at least unlimited.

It will now be in place to show that after making every allowance and deduction experience has proved to be necessary, it is still practically "greatly in excess of all possible requirements."

The first and principal deduction is due to the circumstance that although there may be a great quantity of water in a river and in the aggregate there may be many hundred feet of fall and thus theoretically a large amount of "potential energy" or power, practically, this power may not be recoverable, in regard of those stretches in which the descent is not sudden or rapid but gradual and moderate. Or if recoverable at such an expense only for dams or weirs, in-take lades and tail-races, as may render it undesirable. Thus it happens that in many countries the largest rivers afford little if any available water-power. In other countries owing to the occurrence of rapids or falls at intervals on some of the rivers, more or less of the power may be obtained. But in every country there are considerable stretches, if not the entire rivers, in which the descent is so gradual that the "potential energy" of the water may be said to be lost.

In this respect also Ontario is singularly fortunate. Not only is steadiness in the supply of water ensured by her countless lakes, but the vast number of falls, cataracts and rapids which occur in her streams and rivers render it possible at a reasonable expense to recover and utilize the far greater part of the potential energy of the water. This is particularly the case in regard of the rivers and streams which flow into Lake Superior and Lake Huron, and in most of those also which flow into the Ottawa. The intermediate stretches between the falls and rapids consisting not unfrequently of lakes or lake-like expansions of the rivers in which very little fall is lost.

North of the height of land plateau the percentage or proportion of the power practically recoverable from the water of the rivers which flow into James' Bay will be less. These rivers between the northern edge of the height of land plateau and the foot of the long portages descend in general from six to eight hundred feet The rapids and falls are numerous and capable of affording in the aggregate an enormous amount of power; but there are comparatively few "still-water stretches" between the water-falls and hence a considerable loss. Again below the "Long Portages" these northern rivers flow for a distance varying from 70 miles in the case of the Abittibi to 200 miles in that of the Albany River over a plain or flat belt of country lying to the south and west of James' Bay. In this stretch there is a fall or descent varying from 200 to 400 feet. Theoretically the water is capable of affording an immense amount of power, but practically, owing to the gradual descent, very little is recoverable.

On the other hand at Sault Ste. Marie and Niagara the descent or fall occurs in such short stretches of the river that almost all the power may be said to be available.

Another source of what may be called loss of power is due to the fact that of the water precipitated on the height of land and other plateaus a good deal is lost by absorption and evaporation. And that the sudden melting of the snow in the spring in spite of the lakes (unless they be very large) occasions such a great flow of water for two or three weeks that a comparatively small proportion only of the water in the rivers can then be utilized.

Lastly. Even at points so favourably situated that all the water and all the "head" or fall can be made available the effective power obtained by the best hydraulic engines is not more than three-fourths and more frequently two-thirds only of the theoretical power.

I am convinced, however, after making the largest deductions called for by all the circumstances mentioned that the effective power afforded by the lakes and rivers of Ontario "is practically unlimited," or in other words greatly exceeds all the possible wants and requirements of the largest possible population. The superiority of water-power to steam-power in point of economy, and the extent and excellence of the water-powers of Ontario having been, as I venture to think, sufficiently shown, it now remains to be seen,

1st. Wherein water-power is inferior to steam-power.

2nd. What probability there may be of the obstacles, which have prevented its more general use, being overcome.

Wherein Water-power is Inferior to Steam-power.

The answer to the first question is not far to seek. The superiority of steam-power lies chiefly in the fact that practically it can be had wherever it is wanted and to the amount wanted. In every habitable part of the world fuel of some kind or other can (as yet) be obtained. There is not "a lot" therefore in the largest and most populous city or in any country village; there is not a farm or a mine however remote whereon a steam engine may not be erected with power sufficient for the purposes the owners may have in view. Water-power on the other hand is not obtainable everywhere, but must as a rule be used on the spot where nature has located or planted it. In other words, the "water wheel" or hydraulic engine must be erected at or near the "water-fall." Now, these "Mill sites" as they are commonly called are only found here and there at considerable intervals, even in this highly favored country. They are frequently fewest

in number where the land is the richest and the population greatest. Thus hitherto water-power has rarely been obtainable where it was most wanted.

"Power," as already explained at considerable length, is principally required for manufacturing purposes, and if this were the only thing to be considered the manufacturer would look around for a good water-power and there erect his factory or his mill. But he also requires capital, artisans, materials and customers, and these are most easily obtained at or near the chief centres of population. In Canada (as elsewhere) with few exceptions the towns and cities have been located solely with the view to carrying on a profitable trade with the early settlers, farmers, hunters or trappers and even Indians. The advantages that any particular locality possessed in this respect, whether in regard of inland or ocean navigation or of safety from the assaults of enemies, have been the principal factors in determining their position. As there were no manufacturers, in the modern sense of the term, there was little or no need of power. A stream with water sufficient to drive a small grist or saw-mill for the supply of local wants was generally all that the first pioneers needed, and such might by chance be included in the limits of the future city. But in the selection (natural or otherwise) of the sites on which our older towns and cities have been built the future value and importance of water-power for manufacturing and other purposes has been entirely overlooked.

Hence it happens that in a country abounding above all other in the most economical of powers, such cities as Toronto, Hamilton, London, Kingston and others have no water-powers worth mentioning, and the manufacturers have been obliged to have recourse to the more expensive steam-power or build their mills and factories elsewhere.

The first men to utilize the water-powers of Canada to any considerable extent were, I expect, the lumbermen. And it is probable this circumstance, the excellence of the water-power and the Rideau Canal that have determined the position of Ottawa city.

The total unfitness of water-power in the past to supply the place of steam-power in navigation or on railways is too obvious to call for any particular remark or explanation. What probability is there then that these advantages, which hitherto have so greatly impaired the general usefulness of water-power may be overcome? My answer to this is that they have been already in a great measure overcome by means of electricity. And water-power, always where available superior to steam-power in point of economy, is now its equal in almost every other important respect.

In order to show that these views and opinions are not of recent birth or rashly and hurriedly formed I may be permitted to quote from my report on the northerly territory of the Province of Ontario for 1881-82, in which, on page 11, speaking of the vast deposits of peat in the territory and its probable future value and importance as fuel, I say, "Now, even supposing that with a direct railway the cost of manufacture and transportation would still be such as to exclude both compressed peat and peat charcoal from our markets so long as coal and wood could be obtained at reasonable prices; and still adhering to the belief that both coal and wood will advance in price until they become sooner or later anything but reasonable, he must be a bold man who in view of the discoveries of the last fifty years will contend that in the next fifty years this bountiful provision of fuel may not be made to contribute in some form or other to the welfare, comfort and happiness of the people of this Province.

It appears to me by no means improbable that electricity, now almost

synonymous with light, heat and power, may be generated on the spot where the fuel to drive the necessary engines and machinery can be procured at an almost nominal cost and in unlimited quantity. The electricity so obtained can be transmitted with as much speed, ease and certainty to any point where light, heat or power may be wanted as that which conveys telegraphic messages all over the world.

If electricity generated in Newfoundland can be made to work a machine in Ireland, why may not electricity generated on the spot by our beds of peat and lignite together with the magnificent water-powers on both sides the height of land, be utilized in Toronto or Hamilton not only as a source of light and heat but also as a power wherewith to drive all sorts of machinery, the lighter kinds more especially ?

The discovery of the means by which powerful electric currents can be divided and subdivided and thus apportioned in the degrees or quantities required by different individuals for different purposes has, in my humble opinion, overcome one of the greatest obstacles to the almost universal employment of electricity and that to an extent which may positively revolutionize all existing arrangements, having for their object the production and transmission of light, heat and power not only for domestic but manufacturing purposes. The best mode of transmitting power from situations where it is running to waste and actually worthless, to points more or less remote where it is wanted and would prove of the greatest importance and value has long been a problem that engineers and machinists have been endeavoring to solve, but so far very clumsily and imperfectly. I know few of greater importance, and it appears to me that its solution may be near at hand. What with her unlimited supply of fuel (peat and lignite) in the north and her magnificent water-powers everywhere available in the same manner and to the same end, no country will stand in a better position than Canada should these anticipations be realized."

Again in my report for the year 1882-83, page 31, this important subject was again referred to in the following terms :—

"Since I thus wrote some progress has been made in this direction. Experiments on a large scale are, I believe, being conducted both in Europe and America, the object of which is, to substitute electro-magnetic engines for ordinary locomotives on railways. I am not conversant with the details, but as I understand, the electric fluid (so to speak) is generated or supplied by stationary engines at each end of the line, if short, but at stated intervals if the road is long. The engines which generate the electricity, which in turn propels the train, may themselves be worked by steam or water. These stationary engines may be many miles distant not only from the train and its load, but if necessary, from the railway itself. All, I believe, that is really essential, being, that the electricity thus generated shall be conducted without material loss or waste, by means of wires or otherwise, from the stationary engine to the electro-magnetic engine which accompanies the train ; or the electricity may be stored up according to M. Faure's method, on the point of being patented and introduced into Canada.

"If this system be at all successful in an economic point of view, with stationary engines worked by steam-power, the problem of the utilization of the vast stores of peat and lignite in this territory is, I am persuaded, in a fair way to be solved. The height of land is an extensive plateau (area 35,000 square miles) and not a sharply defined ridge. This plateau is full of lakes, each giving birth to streams of water, which uniting soon become rivers. Some of these flow to the north and others to the south. This plateau is from a thousand to twelve hundred feet above the level of the sea : and from five to seven hundred feet

above Lakes Huron and Superior. Hence the rivers for many miles on both sides the height of land offer a succession of rapids and falls. These afford water-powers, the equal of which cannot in my opinion, be found on this continent, if in any other part of the world. The lakes by which these rivers and streams are fed constitute, in fact, great natural reservoirs, by means of which a constant and steady supply of water, at all seasons can be easily ensured. It is obvious, therefore, that if this method of propelling or drawing trains should prove successful, the motive-power necessary to transport fuel from the north to our very doors, would cost literally nothing but the machinery required to apply it to that purpose. Such a reduction in the cost of transportation as this presupposes, would probably enable us to obtain abundant and cheap fuel for generations to come from our own territory."

Such were the views of the writer ten years ago, and he respectfully claims that the opinions then expressed, and the predictions then made, are strongly supported and borne out by the progress that has since been made in the direction of their fulfilment.

The transmission of power by means of electricity from where it is generated by stationary engines to points more or less distant, to be there employed in driving machinery, the running of street-cars and many other purposes, is no longer a matter of opinion or of doubt. The great number of places where it is thus applied, and the success which has attended it, sets at rest all misgivings as to its entire practicability. It matters not excepting as regards cost, from what source the power is derived, whether it be steam, water or wind, this power can be converted into electricity transmitted through a cable, ten, twenty or more miles, and then re-converted into power again, and used for any purpose, manufacturing or otherwise, for which it may be required. Our ingenious and enterprising neighbours are quite alive to the vast importance of this mode of transmitting power and more particularly of water power. A company (capital $10,000,000) has been formed, and work has been commenced with the view to utilizing at Buffalo a large amount of power (no less, it is estimated, than 150,000 horse-power) to be obtained from the Falls of Niagara.

It is said, too, on the authority of Mr. Edison and other eminent electricians that the scheme is not only practicable, but that the power thus supplied will cost very much less than steam-power. The following extract from the *Electrical World* shows that in Europe it is thought possible to transmit power a much greater distance than from Niagara Falls to Buffalo. Under the heading "A Daring Project," that periodical says: "One of the features of the coming electrical exhibition at Frankfort-on-Main will be the transmission of power on a scale hitherto never attempted. When it was announced some months ago, that it was proposed to transmit one hundred horse-power from Lauffen-on-Neckar to Frankfort, a distance of more than one hundred miles, the statement was received with smiles of incredulity, but now it seems quite probable that not only will the experiment be tried, but that it will succeed in spite of the engineering difficulties that have to be surmounted."

Thus it will be seen, that although as yet far from complete or perfect, the progress made in this mode of transmitting power, during the last ten years, has been such as to justify the greatest degree of confidence that power will very soon be transmitted almost any distance that may be desired, having regard to cost.

Hitherto, if water-power was situated at a lower level than that of the place where it was wished to apply it, the distance to which it could be profitably

transmitted has rarely exceeded two or three miles. Perhaps in no industry, has this limitation in respect of the employment of water-power been more frequently a source of disappointment and regret, than in mining. Within three or four miles of Leadhills and Wanlockhead, but at a lower level, there was water-power far in excess indeed of the requirements of all the mines. Whereas the water which was situated at a higher level, and could alone therefore be brought to the mines in aqueducts or watercourses, was altogether insufficient, resulting at Leadhills as before mentioned, in interminable disputes and lawsuits. The only way in which such power could be transmitted from a lower to a higher station was either by connecting or "slide-rods," or by compressed air. The first of which methods was very clumsy (involving much friction and loss of power), the other too expensive for long distances.

From all which, it follows, that the successful application of electricity to the transmission of power supplies a very important and long felt want, "a missing link" in fact; and as regards water-power more especially cannot fail to increase immensely its usefulness and value. As much so indeed, as did the discoveries of Watt the usefulness and importance of steam-power.

Instead of this power being available only at the place where the water supply and fall may happen to be situated, it can now be utilized anywhere within a radius of at least twenty or thirty miles, by those anxious to obtain it; and the probability is, this distance will be so increased by further discoveries and improvements, that in another ten years, there will not be a village or even homestead in the land, that will not be within range of some one or other of Ontario's magnificent water-powers.

Toronto and Hamilton, nearly equi-distant (in a straight line) from the Falls of Niagara, need not despair of being ultimately able to obtain from that inexhaustible source, all the power they may need for manufacturing and other purposes, be it ever so great. But even if disappointed in this, Toronto can (unless the intervening ridge be composed of rock) obtain a large amount of power from Lake Simcoe, and that, I believe, at a cost per horse-power, no higher than is paid for it in Scotland, where in consequence of the low price of coal steam-power does not cost more than half the price it does in this city. Thus with far cheaper power than any which can be obtained in Birmingham, Manchester, Glasgow or even Newcastle-upon-Tyne, other conditions being equal, the manufacturers not only of Toronto and Hamilton, but of Ontario generally, should, as it humbly appears to me, be able to compete, and that successfully, with those of any other country in the world.

The substitution of steam or water-power, and of machinery for manual labour, in every branch of industry, farming, mining, manufacturing and others, which has been going on so rapidly for one hundred and twenty years has already been noticed.

One point, however, in relation thereto, calls for further remark, and that is, that this "harnessing" as it were, of the great untiring "forces of nature" and compelling them to do much of our hardest, most distressing, and painful labour, is not yet finished, but still goes marching on. Hardly a day or week elapses that we do not read or hear of some fresh conquest, some new application of power or machinery, whereby, what is called a saving of labour is effected. Nor is this surprising when we consider the multitude of people, including thousands of the most talented as well as the most practical, in every pursuit, who are constantly occupied in trying to invent or discover labor-saving machinery, animated and encouraged as they are by the desire for fame, honour and riches,

which in these days the successful discoverer may reasonably expect to reap. This vitally important movement has, in the opinion of the writer, come to stay and is bound to go forward; for although much good work has been accomplished there still remains a great deal to be done. It is, in the main he fervently believes, a truly benign movement, and as such calculated, if not designated to ameliorate very greatly the condition, not only of overwrought working-men, commonly so called, but of some of their dumb fellow-labourers among the domestic animals; the poor horse more especially. One practical conclusion that may be drawn from this report is, that the more universal this substitution of mechanical power for animal power, the greater will be the demand for, and greater the importance and value of our Provincial water-powers.

Electric Railways.

Another very important use (impossible before) to which water-power can now be applied, is in the transportation of passengers, and of farm produce, if not of heavy freight.

The entire practicability of drawing loaded cars by electro-magnetic motors on both railways and tramways may now be said to have been satisfactorily established. For street and suburban railways, electricity is rapidly taking the place both of horses and of locomotive engines. In most places the power required to produce the electricity is furnished by stationary steam-engines; the expense in fuel alone being very considerable. With the command of water-power, the cost of operating electric railways would be greatly reduced. Hence an enormous increase in the number of these lines in Canada may be confidently expected.

The lightness and compactness of the electro-magnetic motors, the facility with which cars provided with these motors can ascend hills (which are "stiff" even for horses) the apparent ease with which they are managed, coupled with the fact that the tramways can be laid down on any common turnpike road without in the least impairing its usefulness otherwise, all point to this mode of transportation, as being admirably adapted to supply not only the wants of cities and their suburbs, but of the rural districts. If water-power be available, not only may passengers, but farm products, be carried at rates considerably lower than those commonly charged the farmer by the present railway companies for short hauls. Hence the probability of such lines being laid down between the more populous rural districts and the nearest towns and cities, at which the products of their farms are usually sold. I find an interesting item in the Fort William *Journal* of February 28th, bearing on this very subject and also taken, I believe, from *The Electric News* before quoted. It is as follows: "In estimating the chances of a settlement of the long-standing troubles in Ireland a most hopeful sign is that the employment of light electric railways or telpherage in that country, is now being seriously considered. It is shown that telpherage lines might be used for bringing to market from the remoter districts parcels of farm produce, which cannot now be marketed economically. In such districts, while the production is not enough to support even a light railway, there is real need of some ready means of reaching the market, especially with perishable goods. The establishment of such means would to a certainty give an enormous impulse to small farming, dairy-farming, poultry raising and other occupations of the peasantry. The carriage of the mails, too, which is now done by horse-cars and foot-messengers, would be enormously expedited. The force of the

greatest objection to the whole scheme, the possible expense, is very much lessened by the fact that water-power exists in plenty and its utilization would minimize the cost of working."

With the unlimited command of water-power that Ontario has been shown to possess, is it not at least possible that some now born, may live to see such light electric railways on all the principal roads in the settled parts of this Province? Not perhaps on every concession road, but still so numerous that not a farmer, country merchant or tradesman but who will be within easy distance of such a line. The writer, in whose lifetime the whole railway system of the world has sprung into existence, should be one of the last to doubt it.

CONSERVATION OF PROVINCIAL RIGHTS.

The exclusive legislative authority of the Parliament of Canada or "Dominion" extends to all matters coming within certain classes of subjects which were agreed upon at the time of Confederation and duly embodied in the British North America Act, 1867.

Included in this schedule will be found two classes of subjects which are sometimes so interpreted as to affect very seriously what may be called "Provincial water rights."

These subjects are:

(1) Navigation and Shipping.

(2) Sea Coast and Inland Fisheries.

The exclusive right of the Dominion to legislate on all matters coming within the class of subjects comprehended under the term "navigation" has been claimed to include (inferentially) the full and complete control of all "navigable waters." Hence the necessity of a definition of the word "navigable."

Again "shipping," what is included under this term? Is it to be interpreted so as to include "vessels with three masts" only, or everything that floats, from an ocean-going ship to a birch-bark canoe? If the latter there is hardly a lake or a stream in the Dominion over which the Federal authorities may not claim full control.

Then we have "fisheries." Are the fisheries here called "inland fisheries" of the same nature as the "sea coast fisheries" with which they are grouped or classed, or something different? Were they to be limited (as they were I believe in this Province at the time of Confederation) to the great inland lakes, Ontario, Erie, Huron and Superior, or to be extended so as to include other lakes, such as Lake of the Woods, through which the international boundary passes, as well as those like Temiscamingue, which form in part the boundaries between different provinces.

Or, are the Dominion authorities entitled to establish what they may be pleased to call "fisheries" on any or all of our interior lakes, from the biggest (Lake Nipigon) to the marsh or pond only a few acres in size but which may contain a few Jack-fish (pike) and suckers?

I trust that such claims to "exclusive," or even to "supreme," authority on the part of the Dominion Government in regard of inland lakes and rivers, more

especially those lying and situated entirely within the province whether on the ground that they are more or less "navigable," or that they contain more or less "fish," if put forward may not be found to be supported by the legal construction of the British North America Act.

For, if admitted, the usufruct of the province in these lakes, whether arising out of the water-power, the devotion of such as are most suitable to "pisciculture," or the drainage of others and reclamation of large tracts of arable land, will be lost, or greatly impaired.

It would seem to the writer the British North America Act (section 109) left vested in each of the provinces the ownership of not only "all the lands, mines, minerals and royalties belonging to the several provinces of Canada, Nova Scotia and New Brunswick at the Union," but of the waters also, such being included in the general term "land" as used in this connection. And that the beds of all the lakes and rivers with the minerals below, the waters above, and the fish and anything else of value in or appertaining as well to the water as to the soil, belongs of right to each province, to be utilized or disposed of as the legislatures of the respective provinces may consider most advantageous. Certain exceptions are made in section 92 of the Act in regard to navigation betwen one province and another, or between a province and any British or foreign country. And also in regard of such works "as may be declared by the Parliament of Canada to be for the general advantage of Canada; or for the advantage of two or more of the provinces." But these exceptions seem to me to *prove* that in all matters of a merely local or private nature (even navigation) the legislatures are left free to do as they please.

These views, long held by the writer, appear to be borne out by the opinions expressed by the Supreme Court of Canada in a case mentioned by Dr. Bourinot on page 132 of his Manual of the Constitutional History of Canada, which has just come under his notice, and here quoted. It is specially important in regard of the fisheries.

"By section 2 of the Fisheries Act of 1868, the Minister of Marine and Fisheries may, where the exclusive right of fishing does not already exist by law, issue, or authorize to be issued, fishery leases and licenses for fisheries and fishing wheresoever situated or carried on, etc." In 1874 the Minister executed a lease of the fishery of a certain portion of a river in New Brunswick, which was some forty or fifty miles above the ebb and flow of the tide, though the stream, for the greater part of that particular portion, is navigable for canoes, small boats and timber. Certain persons in New Brunswick, however, claimed the exclusive right of fishing in this part of the river on the ground that they had received conveyances thereof, and prevented the lessee of the Dominion Government from enjoying the fishery under his lease. The Supreme Court of Canada was at last called upon to decide whether an exclusive right of fishing existed in the parties who had received the conveyances. In other words the court was practically asked to decide the question: Can the Dominion Parliament authorize the Minister of Marine and Fisheries to issue licenses to parties to fish in rivers, such as that described, where the Provincial Government has before or after Confederation granted lands that are bounded on, or extend across such rivers? The Court decided: That the license granted by the Minister of Marine and Fisheries was void, because the Act in question only authorizes the granting of leases "where the exclusive right of fishing does not already exist by law," and in this case the exclusive right belonged to the owners of the land through which that portion of the river flows. That the legislation in regard to "inland and sea fisheries" contemplated by British North America Act is not with reference to

property and civil rights, that is to say, not as to the ownership of the beds or rivers, or of the fisheries, or the rights of individuals therein, but to subjects affecting the fisheries generally, tending to their regulation, protection and preservation, matters of a national and general concern; in other words, all such general laws as enure as well to the benefit of the owners of the fisheries as to the public at large. That the Parliament of the Dominion may properly exercise a general power for the protection and regulation of the fisheries, and may authorize the granting of the licenses where the property, and therefore the right of fishing thereupon, belong to the Dominion, or where such rights do not already exist by law; but it may not interfere with existing exclusive rights of fishing, whether provincial or private. That consequently any lease granted by a Dominion Minister to fish in fresh water non-tidal rivers, which are not the property of the Dominion, or in which the soil is not in the Dominion, is illegal; that where the exclusive right to fish has been acquired as incident to a grant of land through which such river flows the Canadian Parliament has no power to grant a right to fish. "That the ungranted lands in a province being in the Crown for the benefit of the people, the exclusive right to fish follows as an incident, and is in the Crown as trustee for the benefit of the people of the province, and therefore a license by the Minister of Marine and Fisheries would be illegal."

CONSERVATION OF PUBLIC RIGHTS.

This report shows, or is intended to show, the importance of the water-powers of the province to the farmer, the manufacturer and the miner; in fact not only to the employer but the employees engaged in every industry, trade or pursuit. It is thus, a franchise in which the people at large, now and hundreds of years hence, are and will be deeply, nay, vitally interested. It is one, consequently, in which the rights of the Crown, or in other words, of the people, are to be most jealously and carefully guarded.

The writer would, therefore, respectfully but strongly urge that in all future sales of land the water, whether of lakes or rivers (with the exception of that which may be required for domestic and sanitary purposes), should be reserved to the Crown as trustee for the benefit of the people of the province generally. And that water-powers should not be sold, but leased for a term of years, the rent charged varying according to circumstances; the position of the fall or rapid, the difficulties to be overcome before it can be applied or utilized, and even the purposes to which it is to be put, being all taken into consideration.

REVENUE.

The rental of the provincial water-powers appears to the writer a perfectly legitimate source of revenue. One to which no reasonable exception can be taken, that may not with equal, if not greater, force be urged against any other tax whatever. The rent should be very moderate at first, say from one to five dollars per horse power per annum, according to situation, circumstances and contemplated use.

The amount of revenue that may be derived from this source at any particular date cannot be estimated. Much will depend on the fiscal policy of this

and other countries. In the absence of larger markets for our products there can be no sudden or very great demand for increased power. That sooner or later it would yield millions of dollars annually, exceeding in fact any other source of revenue, the writer is fully persuaded.

There is one thing, at least, that is absolutely certain, *water-power will outlive steam-power.* The one may be said to endure forever, the other only so long as coal can be obtained. As coal becomes scarcer and dearer steam-power will cease to be employed and will be superseded by the cheaper water-power wherever available. Where water-power cannot be obtained, "wind-power" may probably be utilized, by means of electricity and storage batteries, to an extent and with such complete success as to rival either of the other powers in cheapness and general usefulness.

In England the consumption of coal is now so great that the large and more easily worked beds or "seams" must inevitably be exhausted before long. As this goes on the cost of working or "winning" will increase and the price of coal will rise until "steam" ceases to be *the cheap power* it has hitherto been. Having but a limited amount of water-power to fall back upon, British manufacturers will thus, in all probability, be obliged to give up manufacturing many important staples with which they have hitherto in a great measure supplied the world. Is it not possible that many of these manufacturers, with their experience, capital, machinery and skilled artisans may in the near future find in Canada a new field and a greater Britain, where, under the banner of Free Trade (which the timid sons of the soil, unconscious of their strength, are as yet afraid to unfurl), they may, with the cheap and unrivalled water-power here at their command and materials produced on this continent, if not on the spot, renew "the industrial strife" with a success quite equal to that which has heretofore rendered the manufacturers and merchants of Great Britain so famous. With such rare facilities in regard of cheap transportation and otherwise, London, Liverpool and Glasgow might still, with advantage, continue to be the chief distributing points for the most part if not all of our Canadian manufactures—not required for home consumption—or to supply the wants of our immediate neighbors on this continent.

Respectfully submitted,

E. B. BORRON,
Stipendiary Magistrate, &c., &c.

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